Matching Daily Data on Resource Use to Fire Suppression Costs

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Abstract

- The quality of an analysis is critically dependent on the quality of the underlying data.
- Measuring cost-effectiveness of fuel treatments on Federal lands remains an important research and policy question.
- Much of past literature focuses on fire-level analysis but using daily data provides an improved analysis lens for identifying fuel treatment effects on suppression costs.
- A major hurdle to daily analyses has been accessing daily suppression cost data.
- For 62 fires (1,125 fire-days), daily suppression cost data from ISuite application were successfully matched to resource use data in the National Interagency Resource Ordering and Status System (ROSS).
- While accessing ISuite data is difficult, ROSS data are somewhat easier to access.
- Based on our matched sample of data we find that a simple count of ROSS category lines for each day, explains a high percentage of variation in daily suppression costs.
- The ISuite cost data, therefore, seem to be capturing resource use well.

The Problem

- Researchers analyzing cost-effectiveness of fuel treatments have consistently been faced with limited availability of adequate suppression cost data.
- As Thompson and Anderson (2015, p. 166) put it: "knowledge gaps and data limitations have precluded direct quantification of the influence of past fuel treatment investments on wildfire suppression expenditures."
- Daily costs are needed to identify fuel treatment effects on costs as the fire moves across the landscape.
- ISuite application collects an array of daily suppression cost data but the Forest Service does not have sufficient resources to make these data available for researchers.
- The ROSS data on suppression resource use is more readily available and has a benefit in that units of resources are equivalent across states.
- Nevertheless, for economic science using monetary values facilitates analysis by bringing resource use into one measurable dimension.

Matched Fire-Days Data by State for 2008-2012

State	Fires	Days	Total Cost ($1,000s)	Cost/Fire ($1,000s)	Cost/Day ($1,000s)
AZ	3	22	$3,779	$1,260	$171.78
CA	10	253	$271,555	$27,503	$1,073.34
CO	2	34	$48,837	$24,419	$1,436.39
ID	3	21	$6,742	$2,247	$321.04
MN	2	73	$24,022	$12,011	$329.07
MT	7	105	$26,965	$3,852	$256.81
NC	1	46	$12,110	$12,110	$263.27
NM	1	14	$4,227	$4,227	$301.92
NV	7	75	$18,433	$2,633	$245.78
OK	1	6	$586	$586	$97.60
OR	8	160	$75,255	$9,407	$470.34
SD	1	4	$540	$540	$134.97
TX	1	4	$1,749	$1,749	$437.27
UT	6	129	$35,524	$5,921	$275.38
VA	2	98	$19,349	$9,674	$197.43
WA	3	31	$11,247	$3,749	$362.82
WY	4	50	$20,926	$5,232	$418.53
Total	62	1,125	$581,847		
Average	3.6	66.2	$34,226	$7,478	$400

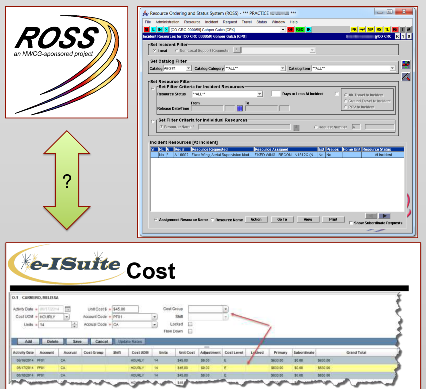

Image Sources: e-ISuite Costs. Version 1.2.2. 12/14/2016. https://famit.nwcg.gov/sites/default/files/e-ISuite_CostUserGuide.pdf, p. 19.
ROSS Module Summary. 11/10/2015. https://famit.nwcg.gov/sites/default/files/ROSS%20Module%20Summary%20Incident%20Resources.pdf , p. 1.

Analysis

- Pooled ordinary least squares estimation is used as a baseline to explore how well the variation in ROSS *Categories* per fire-day explains the variation in ISuite daily suppression *Costs* for fire *f* on day *t*:

$$Costs_{f,t} = \beta_0 + \beta_1 * Categories_{f,t} + \varepsilon_{f,t}$$

- Additional analysis included fire fixed effects, allowing the constant term β_0 to vary by fire.
- The Hausman test rejected the random effects model in favor of fixed effects in this equation.

- Over 500 possible ROSS *Categories* are available in the dataset but with 1,125 observations, not all these could conceivably included in the analysis.
- Regression analysis used 53 *Categories* and reports coefficients for a subset of those:

VARIABLES	(1) Pooled OLS All Fires	(2) Fixed Effects All Fires	(3) Fixed Effects Cal Fires	(4) Fixed Effects Non-Cal Fires
AirtankerType1	54.445***	45.464***	56.139***	52.139***
AirtankerType2	42.887***	42.730***	62.811***	31.619***
AirtankerType3MultiEng	29.419***	27.264***	33.162***	19.205**
AirtankerType3SingleEng	22.496***	24.760***	123.108*	18.785***
AirtankerType4SingleEng	-38.021***	-21.126**	-63.410	-16.429***
CrewType1	22.835***	26.238***	30.472***	18.685***
CrewType2	4.590**	5.312**	20.163**	4.764***
CrewType2IA	11.459***	15.837***	15.416	11.514***
EngineSTType1	24.377***	28.255***	34.160***	17.907
EngineSTType2	21.378	76.257***	130.878***	
EngineSTType3	25.980***	17.823***	15.209***	58.516**
EngineSTType467	22.856**	27.013***	82.190	17.642***
EngineType1	3.277	-12.228***	0.683	18.880***
EngineType2	13.593	31.460**	53.564	-2.609
EngineType3	4.264***	8.035***	8.940*	4.439***
EngineType4567	3.160***	2.757***	-6.129	3.074***
FixedWing	4.379	5.510	-9.488	8.693***
HelicopterType1	11.731***	4.893	-42.166***	28.420***
HelicopterType2	-9.221*	-16.393***	-15.679	-2.783
HelicopterType3	11.418**	11.428*	-25.423	15.766***
ShowerMobile	88.925***	44.195***	109.962***	0.169
Observations	1,125	1,125	253	872
R-squared	0.965	0.984	0.990	0.986

*** p<0.01, ** p<0.05, * p<0.1

- Type 1 resources, typically although not always, increase *Costs* more than Type 2 resources.
- Some ROSS categories might be capturing specific characteristics of the fire (e.g. Airtanker Type 4 Single Engines tend to be used on BLM lands and therefore, the negative coefficient might be capturing lower suppression costs of BLM fires).
- Estimates are different for California.

Results

- Daily observations from ISuite match up well with ROSS data, albeit not perfectly.
- About 96% of variation in daily *Costs* (from ISuite) can be explained by variation in ROSS resource use *Categories*, for the matched days.
- Using more detailed (and a larger number of) ROSS *Categories* does not increase explanatory power much.
- The relationship between ROSS *Categories* and *Costs* varies across states (specifically California vs. not).
- In Fixed Effects model, the highest intercept terms are estimated for following fires: High Park – CO, North Pass – CA, Salmon – NV, and Sayre – CA.
- These are preliminary results and warrant further evaluation of fire-level data to ensure that data entry was comparable across fires.

Conclusions

- A large percentage of variation in ISuite daily *Costs* can be explained by variation in ROSS resource use *Categories*.
- As the number of ROSS *Categories* is changed from a high of several hundred to a low of three dozen, the fit of the model remains approximately the same.
- Including fire fixed effects, after ROSS *Categories*, increases explanatory power of the model only slightly.
- The coefficient estimates are somewhat sensitive to how aircraft use is measured (in hours per day vs. number of aircraft) but main results remain unchanged.
- Preliminary analysis confirms that ISuite suppression cost data for our sample of 62 fires match well with ROSS resource use.

Reference

Thompson, M.P.; Anderson, N.M. 2015. "Modeling fuel treatment impacts on fire suppression cost savings: A review," *California Agriculture*, 69(3), 164-170.

Acknowledgements

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